EXHIBIT B

United States District Court
Western District of Washington

Jennifer Dold Plaintiff, v. Snohomish County, et al, Defendants.	No. 2:20-cv-00383-RAJ

EXPERT REPORT OF MARK KROLL, PhD, FACC, FHRS, FIEEE, FAIMBE

This report summarizes my analysis and findings and includes a statement of my opinions. The report also includes data and other information considered by me in forming my opinions and sets out my qualifications (including my CV which is an integral part of this report).

Mark Kroll, PhD, FACC, FHRS, FAIMBE 3 March 2021

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Glossary & Abbreviations

1. *Conducted electrical weapon (CEW): handheld probe-launching electrical weapon*
2. *To control electronically: to successfully use a CEW*
3. *Electronic control: the goal of controlling electronically*
4. *Deployment: launch of probes*
5. *Electrocution: death from electricity*

Brief Summary of Qualifications

I am a Biomedical scientist with a primary specialty in bioelectricity or the interaction of electricity and the body.* I have invested most of my career researching and developing electrical devices to diagnose and treat disease. The primary focus is the effect of electrical shocks on the human body.

This involves researching, lecturing, and publishing on electric shocks and their effects on the human body. It includes lectures throughout Europe, South America, and Asia (in 35 countries) as well as at many of the major universities and medical centers of the United States (U.S.). Usually, the typical audience member is a cardiologist electrophysiologist, medical examiner, or forensic pathologist. With over 380 issued U. S. patents and numerous pending and international patents, I currently hold the most patents on electrical medical devices of anyone in the world. Over 1 million people have had devices with some of these patented features in their chest, monitoring every heartbeat. http://bme.umn.edu/people/adjunct/kroll.html.

In 2010 was awarded the Career Achievement Award by the Engineering in Medicine and Biology Society (EMBS) of the Institute of Electrical and Electronics Engineers (IEEE) which is the most prestigious award given internationally in Biomedical Engineering.
http://tc-therapeutic-systems.embs.org/whatsnew/index.html

Believed to be the only individual to receive the high "Fellow" honor from both Cardiology and Biomedical societies. To wit:

1997 Fellow, American College of Cardiology
2009 Fellow, Heart Rhythm Society
2011 Fellow, IEEE Engineering in Medicine and Biology Society
2013 Fellow, American Institute for Medical and Biological Engineering

Author of over 200 abstracts, papers, and book chapters and also the coeditor of 4 books including the only 2 scientific treatises on Conducted Electrical Weapons (CEW):

1. TASER® Conducted Electrical Weapons: Physiology, Pathology and Law. Springer-Kluwer 2009.
2. Atlas of Conducted Electrical Weapon Wounds and Forensic Analysis: Springer-Kluwer 2012.

*See current CV for further details and specifics. My curriculum vitae containing details of my relevant formal education, experience, and publications authored is attached and made an integral part of this report.

Directly relevant paper publications include over 100 papers, books, book chapters, indexed letters on CEWs and arrest-related death (ARD), and numerous scientific meeting abstracts. For more details please see CV at: https://www.dropbox.com/sh/wju0hu6q3ca62xx/AAAlzTlLbKbxu5m34AsMfCrYa?dl=0

There have also been many presentations on CEWs to scientific, medical, pathology, as well as law enforcement, audiences. These include: 2007 American Academy of Forensic Science (AAFS) conference major presentation in San Antonio, Texas and the 2007 BEMS (Bio-electromagnetic Society) meeting Plenary Address in Kanazawa, Japan.

1. Major invited lecture at the 2006 NAME (National Association of Medical Examiners) conference in San Antonio, Texas.
2. Advanced Death Investigation Course of St. Louis University (2007) as faculty lecturer to full audience.
3. Faculty lecturer to full audience at Institute for the Prevention of In-Custody Death Conferences (2006 and 2007), Las Vegas, Nevada.
4. Chair of special session on TASER CEW at 2006 Cardiostim meeting in Nice, France.
5. Guest lecture to U.S. Military on CEW in 2006.
6. "Presenting Rhythm in Sudden Custodial Deaths After Use of TASER® Electronic Control Device," was presented at the 2008 scientific conference of the Heart Rhythm Society.
7. "Can Electrical-Conductive Weapons (TASER®) alter the functional integrity of pacemakers and defibrillators and cause rapid myocardial capture?" was presented at the 2008 scientific conference of the Heart Rhythm Society.
8. "Weight-Adjusted Meta-Analysis of Fibrillation Risk From TASER® Conducted Electrical Weapons" presented at the 2009 AAFS conference.
9. "Meta-Analysis of Fibrillation Risk From TASER® Conducted Electrical Weapons as a Function of Body Mass" presented at the 2009 scientific conference of the Heart Rhythm Society.
10. Oral presentation at the 2014 NAME (National Association of Medical Examiners) conference in Portland, Oregon.
11. Pathophysiological Aspects of Electroshock Weapons. University of Salzburg Electroshock Weapon Symposium. Salzburg, Austria. July 2015.
12. Real and Imagined Risk of Electrical Weapons. University of Salzburg Electroshock Weapon Symposium. Salzburg, Austria. Dec 2016.

In addition to the major addresses above, there have been lectures and presentations at the U.S. Department of Justice (2007), AAFS (2006), and BEMS (2006) regarding TASER CEWs.

I have deployed and discharged TASER CEWs numerous times and have personally experienced a TASER® X26 CEW probe deployment discharge to the center of my chest.

Relevant Committees and Boards:

1. International Electrotechnical Commission (IEC) (Geneva, Switzerland) TC64 MT4 Committee. This committee is the top international authority for setting the international electrical safety limits for electrocution and other electrical dangers.
2. American Society for Testing and Materials) ASTM, Committee: E54 Homeland Security Applications, Subcommittee: E54.08 Operational Equipment, including Less-Lethal Task Group, including: ASTM (draft) Standard WK61808 New Test Method for Correct Performance of Less-Lethal Electroshock Weapons Used by Law Enforcement and Corrections.
3. Axon Enterprise, Inc. (Axon né TASER), corporate and also Scientific and Medical Advisory Board.
4. ANSI (American National Standards Institute) standards committee on electrical weapons.

Courtroom testimony in U.S., Australia, and Canada, and retained expert in the United Kingdom and France. I also have significant research, publications, and testimony in the areas of resuscitation, ARDs (arrest-related death), prone restraint, and biomechanics.

Brief Summary of Important Background Facts

1. Major studies sponsored by the US DOJ show that use of electronic control reduces the suspect injury rate by at least 2/3 compared to alternative force options, including hands-on physical force.[1,2] The MacDonald study covered 12 USA law enforcement agencies and 24,380 uses of force.[1] They found that the CEW reduced subject injury by 65%. Taylor et al analyzed data from 13 USA agencies including 16,918 uses of force and described a 78% reduction in injuries requiring medical attention.[2] In other words, the peer-reviewed literature shows that the use of other control techniques will at least triple (3x) the injury rate compared to the use of a Conducted Electrical Weapon (CEW).

2. The use of electrical weapons reduces fatal officer involved shootings by 2/3 where the electrical weapon usage is not overly restricted.[3] The use of electrical weapons reduces the non-firearm arrest-related death rate by 2/3 compared to other force options.[4]

3. The X26E and X26P CEWs used by the agency deliver a safe level of electrical current as specified by the Underwriters Laboratories (UL) and International Electric Fence standards.[5] In fact, they satisfy all relevant electrical safety standards.[6-8] The orginal TASER® X26 CEW is now often referred to as the X26(E) to distinguish it from the newer X26P.

4. The X26P delivers ~1.6 W which satisfies the UL electric fence safety limit of an equivalent of 5 W and even the more conservative 2.5 W international limit.[9,10] The X26(E) delivers ~1.8 watts (W) which satisfies the UL electric fence safety limit of an equivalent of 5 W and even the more conservative 2.5 W international limit.[9,10]

5. The UL electric fence safety standard allows the delivery of 5 watts for short pulses as those from the X26E and X26P.

6. The X26P CEW satisfies the ANSI CPLSO-17:2017 "Electrical Characteristics of ECDs and CEWs" standard.[11]

Brief Summary of Opinions in This Case

1. Mr. Dold received 9.5 seconds of probe-mode shocks from the X26E and X26P CEW.

2. Mr. Dold had his cardiac arrest about 15 minutes after the last probe-mode shock delivery thus eliminating the possibility of electrocution.

3. Mr. Dold was still fighting about 12 minutes after the last probe-mode shock delivery thus eliminating the possibility of electrocution.

4. Mr. Dold' cardiac arrest rhythms were asystole and PEA (pulseless electrical activity) thus eliminating the possibility of electrocution.

5. The usage of the electrical weapons did not cause Mr. Dold's tragic death.

6. The usage of the electrical weapons did not contribute to Mr. Dold's tragic death.

Benefits and Risks of Electronic Control

Electronic control benefits are well-established in the peer-reviewed literature and explain why these weapons are so widely adopted throughout the industrialized world (107 countries). Subject injury rates are cut by ≈ 2/3. The MacDonald study covered 12 USA law enforcement agencies and 24,380 uses of force.[1] They found that the CEW reduced subject injury by 65%. Taylor et al analyzed data from 13 USA agencies including 16,918 uses of force and described a 78% reduction in injuries requiring medical attention.[2] In other words, the use of alternative force options, including hands-on physical force, tends to *at least* triple (3x) the injury rate compared to the CEW. [1,2]
The number of law enforcement firearms shootings prevented has been estimated at over 220,000 based on the 4.1 million CEW field uses.[12,13] In agencies using the CEW with minimal restrictions, the fatal officer shooting rate falls by ≈ 2/3.[3] The overall reduction in the ARD (arrest-related-death) rate is 59-66%.[14]

Table 1. Primary risks from CEW probe-mode applications.

Risk	Findings	Notes
Primary (Direct) Risks		
Electrocution	Theoretical possibility with fully embedded dart directly over heart in subjects under 46 lbs.[15] In general, electrocution events in adults is an urban legend.[16-18]	Present CEWs satisfy all world electrical safety standards.
Loss of vision	Demonstrated with probe penetrating the eye.[19-22]	
Primary Secondary (Indirect) Risks		
Head injury from fall.	Fatalities demonstrated.[23] Non-fatal injuries demonstrated.[24,25]	
Fume ignition.	Fatalities demonstrated.[26,27]	

The primary demonstrated and theoretical risks supported by the existing literature are outlined in Table 1. The most common contribution to fatality is a secondary injury from a head impact from an uncontrolled fall. If the subject is running or above a hard or elevated surface, and receives a CEW probe deployment, the unbroken fall can sometimes result in a serious head injury and there have been 16 deaths due to this.[23] This has not been reported with the drive (or contact or touch)-stun mode as there is no muscle lock-up. There have been 8 secondary fatalities in which flammable fumes were ignited by an electrical spark from the CEW.[14,26,27] This has not been reported with drive (or contact or touch)-stuns although that remains a theoretical possibility.

The most misunderstood and exaggerated theoretical risk is that of electrocution. This is extremely unlikely as the output of existing CEWs satisfy all relevant world electrical safety and effectiveness standards including those for the ubiquitous electric fence.[5,6,8,11] The conservative IEC (International Electrotechnical Commission) standard allows up to 2.5 W (watts) for an electric

fence and all present TASER CEWs deliver less than 2 W.[9] Underwriters Laboratories (UL) allows 5 W for narrow pulses such as those of TASER CEWs.[10] The primary driver of this myth appears to be the fundraising material of Amnesty International, and some sensationalistic media, that lists Arrest-Related Deaths (ARDs) along with the innuendo that the CEW somehow electrocuted the subject. Notably, they have never attempted to explain how a CEW that satisfies all electrical safety standards could ever electrocute anyone.

Swine are 3 times as sensitive to electrical current as humans.[28] The largest swine electrocuted by an X26E CEW was that of Valentino with a 10-second CEW discharge and it weighed 36 kg (79 lb.).[29] Nanthakumar also electrocuted a *single* 50 kg swine with a 15 second CEW discharge but he used a drug trick which made the swine's weight equivalent to ≈ 30 kg.[30] Hence the largest swine ever electrocuted by a CEW weighed only 36 kg.

The levels of dangerous electrical current scale with body mass just like a drug dosage. Since swine are 3 times as sensitive to electrical current (as humans) this is translated to the single Valentino 36 kg pig to a 12 kg (26 lb.) human.[28] This calculation uses a direct-proportion relationship of dangerous current levels to the body mass. Some authorities have published that the danger level scales with the square root of body mass.[31] With such a relationship the Valentino pig is equivalent to a larger 21 kg (46 lb) human. Taking the more conservative calculation, the best evidence suggests that the risk of CEW electrocution is limited to humans weighing less than 46 lbs.

Most authorities agree that electrocution is a theoretical possibility with an extremely thin individual and a fully penetrated dart directly over the heart in a very thin person with a very small dart-to-heart distance (DTH).[32-34]

Table 2. Summary of benefits and risks of CEWs.

	Item	Rate
Benefits:	Subject injury	2/3 reduction
	Subject death	2/3 reduction
Risks:	Fatal fall	1:200,000
	Fatal or nonfatal major burn	1:360,000
	Blindness from dart	1:200,000

The very rare risks of CEW complications are swamped by the lives saved and serious injuries minimized from the reductions of ARDs. For every ARD from a CEW complication (fatal fall or fire) there are 50 ARDs prevented by reducing firearm shootings and over-exertional deaths. Additionally, there is 1 temporal ARD for every 1,000 traditional uses of force, or 1 temporal ARD for every 3,500 uses of CEWs.[14,23]

Relevance to This Case:

1. There was no electrocution risk to Mr. Dold from the electrical weapons.

Major Myths

Because electricity is invisible and potentially dangerous (at high currents) there is widespread fear and misunderstanding of it among the public and the legal profession. See ***A. The Electrophobia Myth*** at page 35 of this report. Due to unscientific media sensationalism and litigation, this has contributed to some widespread urban myths surrounding electrical weapons.

It may prove helpful to discuss some of these myths before delving into greater details of this incident.

Myth #1. People Have Been Electrocuted by an Electrical Weapon.

Speculations of electrocution by a handheld electrical weapon should be viewed with great skepticism since these weapons satisfy all relevant USA and international electrical safety standards. (The single exception is the Brazilian Condor® Spark which satisfies the Underwriters Laboratory but not the European electric fence power limits.)

Numerous swine and human studies suggest that the risk of CEW electrocution is limited to humans weighing less than 21 kg (46 lbs.) and requires a perfect fully-penetrated probe directly over the heart.[29,32,35] A major driver of this electrocution myth was the Zipes-Burton case series. John Burton is a lawyer specializing in suing law enforcement and Dr. Douglas Zipes was his expert witness. They published summaries of their 8 CEW cases in 2012.[36] It was full of errors including a case where the CEW probes missed the subject. Later the journal, *Circulation*, required Dr. Zipes to acknowledge Mr. Burton as his co-author and to admit that they had mischaracterized the subjects as "clinically normal."

In addition, the Zipes-Burton case series was analyzed by the Canadian Council of Science.[16] Their peer-reviewed report (Oct 2013) was produced by a deliberative panel that included numerous Canadian and USA experts on electrical weapons and arrest-related death (ARD) and was extensively peer-reviewed. This panel dismissed the Zipes-Burton case series.[36] The Canadian Council report was very direct:

> The study by Zipes is particularly questionable since the author had a potential conflict of interest and used eight isolated and controversial cases as part of the analysis.

In 2013 the journal, *Circulation*, invited me to submit a refutation which I did with 2 cardiologists and a cardiac pathologist. This was published Jan 2014 so the Zipes-Burton paper has been refuted for already 7 years.[37]

Myth #2. The AHA did a Study Proving Electrocution

Since the journal *Circulation* is published by the AHA (American Heart Association), the above myth sometimes appears in a more dramatic fashion: "The American Heart Association did a study proving that 'tasers' can electrocute."

Myth #3. The Baseball Rule has a Scientific Basis.

Many law enforcement agencies have policies and guidelines limiting officers to 3 trigger pulls (or 15 seconds) and this is generally referred to as the "baseball rule" in analogy to the 3-strikes allowed in that game. While I do not give legal opinions, I do understand that there are decisions ruling that each trigger pull, just like each strike with a baton, fist, or foot, and each exposure to OC spray is a distinct use of force which must be legally acceptable and thus in some instances there is legal rationale supporting something like the baseball rule. Ironically, no agencies limit their officers to 3 rounds in their firearms, 3 baton strikes, 3 OC spray squirts, 3 strikes with a physical weapon, or 3 arm bars.

This guideline is often taught as a "transition rule" teaching that officers should consider force-option transition to a *different* control technique if 3 CEW trigger pulls do not suffice in accomplishing the officer's force objective. That dogma is questionable as the most appropriate *different* transition tool would be the firearm since the electrical weapon is the most effective intermediate force option.[1,2] A transition to pain-compliance tools, such as chemical agents, impact tools, or impact projectiles would not be helpful as they are generally less effective on subjects in the throes of a mind-body disconnect.

Well over 100 years of electrical research has demonstrated that the effects of electricity do not build up like poison. Specifically, the USA military has tested this in swine with continuous CEW exposures across the chest for up to 30 minutes — not 30 seconds.[38] If someone is electrocuted this generally occurs within 1 second with an upper limit of ≈ 2–5 seconds.[39-42] If an electrical current is strong enough to kill someone it will do so in the first few seconds of exposure and a longer exposure duration simply has no additional effect. There is no increased danger in going from 5 seconds of electrical current to 50 seconds. See ***The Dogma Of 3 Strikes And 15 Seconds.*** at page 45.

A scientifically-supported CEW transition rule would be as follows:

1. The officer should note if their CEW is failing to incapacitate the subject. This is typically noted in a few seconds — not 15 seconds.
2. The officer should transition to a different CEW cartridge and redeploy since the primary reason for lack of incapacitation performance is a bad connection.

Current model CEWs, such as the X2 and the T7 CEWs, hold 2 cartridges and thus this transition issue is minimized. If the officer does not achieve sufficient incapacitation, they can simply pull the CEW trigger again and deploy a 2nd pair of probes so the "transition" rule becomes obsolete.

There is no scientific basis to the baseball rule.

Myth #4. Simultaneous Trigger-Pulls are More Dangerous.

Due to the numerous potential limitations of electrical weapons, such as small probe-spreads, broken wires, missing probes, and clothing disconnects, officers may need to provide a back-up simultaneous deployment — especially in an urgent situation or where the subject is reasonably perceived as a significant immediate threat. In fact, current model CEWs such as the X2 and the T7 CEWs, hold 4 probes and thus this can be done by a single officer. I.e. a single officer can now easily deliver "simultaneous" currents into a subject.

As a practical matter, true simultaneous current delivery almost never occurs as the reason for a backup deployment is usually the failure of the primary deployment. The cardiac, breathing and biomarker effects of simultaneous CEW discharges has been extensively studied. The application of 2 and 3 simultaneous discharges (4 and 6 contacts) into human volunteers was tested a decade ago and no deleterious effects were noted.[43,44] Other studies have tested 10-second continuous exposures with up to 4 probes (2 simultaneous discharges) without ill effects.[45,46] Nevertheless, this obsolete rule persists in many agencies even though the current model electrical weapons make it, for all practical purposes, irrelevant.

Myth #5. The Heart is a Muscle, so it is Affected Like Skeletal Muscles

This is an older myth that has largely died out with the numerous animal and human studies published in the last decade. The basic message is the innuendo that electrical weapons must be able to electrocute (i.e. stop the heart) since they stimulate the skeletal muscles. It is easily dealt with by noting:

1. Skeletal muscles are on the outside of the body while the heart is on the inside of the body.
2. Electrical current tends to follow the grain of the muscles and thus it mostly stays within the skeletal muscles and does not dive down to the internal organs.[47-49]
3. Skeletal muscles are controlled by nerves coming from the spinal cord while the heart provides its own stimulation.[50-52]

Shocks vs Trigger Pulls

What is a Shock?

A shock is an electrical current strong enough to cause either pain or a change to the body. (Some definitions require "injury" vs a "change" but we will use the broader definition here.) We all experience electrical currents that are *not* shocks:

1. The classic example is the touch-light in your home. See Figure 1. It passes a current into your body, but you don't feel it. *Hence it is not a shock.*

2. Same with the body-fat bathroom scale that I use. See Figure 2. It passes current thru my legs, but I do not feel anything, so it does not deliver a shock.

Figure 1. Touch lamps pass electric current into our body but we do not feel it.

The Merriam-Webster dictionary uses a more restrictive definition of "shock," than we bioelectrical specialists use (they do not include mere pain but require a muscle contraction):

> sudden stimulation of the nerves and convulsive contraction of the muscles caused by the discharge of electricity through the animal body

That distinction does not really matter, in this case, as Mr. Dold had a clearly elevated pain threshold.

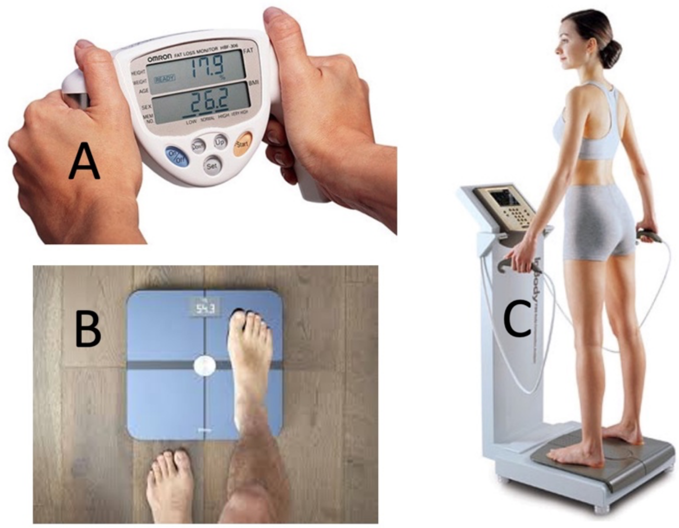

Figure 2. Electrical body fat meters use the arms (A), legs (B), or whole body (C).

An electric current that is not perceived — such as a drive-stun to someone in a schizophrenic break — is not a shock. However, a probe- mode application can cause a muscle contraction, and this is a shock even to someone in a schizophrenic break or anesthetized by drugs.

What is a Trigger Pull?

A trigger pole is what is recorded in the electrical weapon internal circuitry. It does not imply that any current was delivered. Please see later section Misunderstanding the Trigger-pull Download on page 27 for details.

Trigger Pull Timing

Table 3. Download clock drift correction for Ofc. McCoy

Closest Clock Correction	29-Mar-17	
Previous Clock Correction	22-Feb-17	
Shown Time	10:06:07	
Actual Time	10:06:12	
Elapsed Days	35	
Drift (min:sec)	-0:00:05	Positive = "fast"
Seconds of Drift	-5	
Drift Rate: Seconds per Day	-0.14	
Date of Incident	21-Mar-17	
Closest Clock Correction	29-Mar-17	
Days Elapsed from Correction	-8	
Predicted Seconds of Drift	1.1	
Predicted Drift (min:sec)	0:00:01	from closest post- correction
Total Correction	-0:00:04	
Raw Time of 1st Trigger Pull	21:52:21	Local
Predicted Actual Time TP1	21:52:25	Local
(End time for old models, start for new models)		
Raw Time of Last Trigger Pull	21:53:58	Local
Predicted Actual Time of Last Trigger Pull	21:54:02	Local
(End time for old models, start for new models)		

Table 4. Download clock drift correction for Ofc. McGee

Closest Clock Correction	29-Mar-17	
Previous Clock Correction	23-Mar-16	
Shown Time	10:38:40	
Actual Time	10:25:35	
Elapsed Days	371	
Drift (min:sec)	0:13:05	Positive = "fast"
Seconds of Drift	785	
Drift Rate: Seconds per Day	2.12	
Date of Incident	21-Mar-17	
Closest Clock Correction	29-Mar-17	
Days Elapsed from Correction	-8	
Predicted Seconds of Drift	-16.9	
Predicted Drift (min:sec)	-0:00:17	from closest post- correction
Total Correction	0:12:48	
Raw Time of 1st Trigger Pull	22:05:40	Local
Predicted Actual Time Trigger Pull	21:52:52	Local
(End time for old models, start for new models)		
Raw Time of Last Trigger Pull	22:06:11	Local
Predicted Actual Time of Last Trigger Pull	21:53:23	Local
(End time for old models, start for new models)		

Table 5. Download clock drift correction for Ofc. Johnson

Closest Clock Correction	29-Mar-17	
Previous Clock Correction	9-Nov-16	
Shown Time	9:29:13	
Actual Time	9:25:09	
Elapsed Days	140	
Drift (min:sec)	0:04:04	Positive = "fast"
Seconds of Drift	244	
Drift Rate: Seconds per Day	1.74	
Date of Incident	21-Mar-17	
Closest Clock Correction	29-Mar-17	
Days Elapsed from Correction	-8	
Predicted Seconds of Drift	-13.9	
Predicted Drift (min:sec)	-0:00:14	from closest post-incident correction
Total Correction	0:03:50	
Raw Time of 1st Trigger Pull	22:08:19	Local
Predicted Actual Time Trigger Pull	22:04:29	Local
(End time for old models, time for new models)		
Raw Time of Last Trigger Pull		Local
Predicted Actual Time of Last Trigger Pull	-0:03:50	Local
(End time for old models, start for new models)		

Table 6. List of trigger pulls.

TP #	Time	Trigger Pull (Start)	Model	Mode	TP Duration (s)	Gap (s)	Pulse-log Current	Probe Current (s)	Notes
1	21:52:25	McCoy TP1	X26P	Probe	5		4.5	4.5	Yell only
2	21:52:47	McGee TP1	X26E	Probe	5	17		5	Probes to abdomen
3	21:52:59	McGee TP2	X26E	No contact	5	7		0	Probe dislodged from forearm
4	21:53:18	McGee TP3	X26E	Drive-stun	5	14		0	
5	21:53:49	McCoy TP2	X26P	Drive-stun	3	26	0.8	0	No effect
6	21:54:02	McCoy TP3	X26P	Drive-stun	5	10	1.5	0	
7	22:04:17	Johnson TP	X26E	Drive-stun	12	610		0	
				Total	40			9.5	

Details of Trigger Pulls

Trigger Pull #1

Dep. McCoy deployed his X26P probes towards Mr. Dold and the pulse logs show 4.5 seconds of current delivered. It is likely that the probes landed very close together as there was no electronic control. Mr. Dold's only response was a brief yell which demonstrates an extremely high pain threshold.

Dep. McCoy then removed the cartridge in preparation for possible later drive stuns.

Trigger Pull #2

After a 17 second delay (from the end of the trigger pull #1), Dep. McGee deployed his X26E probes towards Mr. Dold. The older X26E does not have pulse logs so we do not know how many seconds of current was delivered. A conservative estimate would be the maximum 5 seconds in the recorded trigger pull.

There was some electronic control and the deputies were able to get Mr. Dold off the bed onto the ground. This level of movement will typically break the delicate wires of the probes.

Trigger Pull #3

After a 7 second delay (from the end of the trigger pull #2), Dep. McGee pulled the X26E trigger again but there was no response. That would be consistent with a wire breaking or a probe dislodging.

Dep. McGee recalled that a probe had fallen out of Mr. Dold's forearm. Detective Barrows later found loose TASER CEW probes inside the bedroom of this part of the struggle.

Trigger Pull #4

Dep. McGee attempted a drive-stun 14 seconds after the end of TP #3. While the X26E does not have pulse logs we know from experience that current is delivered for ~30% of a drive-stun duration and that would give 1.5 seconds of current.

Trigger Pull #5

Dep. McCoy attempted a drive-stun 26 seconds after the end of TP #4. The pulse logs show a 3-second trigger pull with only 0.8 seconds of contact.

Trigger Pull #6

Dep. McCoy attempted a final drive-stun 10 seconds after the end of TP #5. The pulse logs show a 5-second trigger pull with only 1.5 seconds of contact.

Trigger Pull #7

After over 10 minutes, Sgt. Johnson attempted a 12-seconds drive-stun with "little to no effect." While his X26E did not have pulse logs we know from experience that current is delivered for about ~30% of the duration and that would give 3.6 seconds of surface current.

Master Time-line

Table 7. Master time-line

Time	Event	Source	Time from last probe-mode TP
21:18:36	Deputies dispatched to a verbal and physical male	SMART Report	
21:19:28	Dispatch advised subject was mental and off meds.	SMART Report	
21:47:30	Dep. McGee and Dep. McCoy arrived on scene	SMART Report	
21:52:25	McCoy TP1 START	X26P Download	
21:52:47	McGee TP1 START	X26E Download	
21:52:47	McGee TP1 END (Probe mode)	X26E Download	0:00:00
21:53:01	"Air closed. Taser deployed."	SMART Report	0:00:14
21:53:23	McGee TP3 END (Drive-stun)	X26E Download	0:00:36
21:54:07	McCoy TP3 END (Drive-stun)	X26P Download	0:01:20
21:54:48	"Send us more help."	SMART Report	0:02:01
21:57:27	"Hurry up."	SMART Report	0:04:40
21:57:30	EMS Alarm	EMS Run Sheet	0:04:43
22:00:22	"Need units now."	SMART Report	0:07:35
22:04:17	Johnson TP START (Drive-stun)	X26E Download	0:11:30
22:04:29	Johnson TP END (Drive-stun)	X26E Download	0:11:42
22:05:08	"Subject is 10-15"	SMART Report	0:12:21
22:08:30	Unit A74 Arrival	EMS Run Sheet	0:15:43
22:08:34	"He's got a weak pulse, we're doing CPR now"	SMART Report	0:15:47
22:09:30	Unit B71 Arrival	EMS Run Sheet	0:16:43
22:17:30	Unit M71 Arrival	EMS Run Sheet	0:24:43
22:19:30	*PEA & asystole*	M71 Report	0:26:43
22:24:30	Unit A31 Arrival	EMS Run Sheet	0:31:43
23:02:30	Resuscitation ceased	SMART Report	1:09:43

Details of Other Opinions

1. The Drive-Stun Attempts Are Irrelevant To This Analysis

See later section, "C. CEW Drive Stun Mode: Skin Rub vs. Injection" on page 36. The 2 important things to recall about drive-stuns is that they function only to deliver pain in a "normal" sober person (someone not anesthetized by alcohol or drugs and not in a schizophrenic break). And, there is no current delivered to internal organs and thus there is not even a theoretical possibility of causing an electrocution.

2. Mr. Dold Fought For 12 Minutes After The Last Shock.

Mr. Dold was still fighting at 22:04:29 and he was not reported under control until 22:05:08.

The prolonged struggle after the last Probe-mode shock eliminates electrocution as a possible cause of death.

3. The Cardiac Arrest Occurred About 15 Minutes Later.

The last (probe-mode) shock ended at 21:52:47. Mr. Dold's cardiac arrest was noted around 22:08:34 which is over 15 minutes later. With an electrocution the pulse is lost instantly, and consciousness is lost within 13 seconds.[41,53]

The delay to the cardiac arrest after the last probe-mode shock eliminates electrocution as a possible cause of death.

4. Mr. Dold' Cardiac Arrest Rhythm Was Asystole and PEA.

Mr. Dold' cardiac arrest rhythms were asystole (flat-line) and pulseless electrical activity (PEA). Asystole and PEA are the typical non-shockable cardiac arrest rhythms and are not inducible with electrical stimulation. [54-59] Electrically-induced VF will eventually deteriorate into asystole or PEA. Without chest-compressions, this takes over 30 minutes.[60] With CPR, the time for VF to deteriorate to asystole or PEA is even longer — around 60 minutes or more.[61]

M71/E31 requested by B71/A74/SCSO on scene for med x response. On arrival, multiple SCSO units on scene directed M71 into driveway. Approached thescene found an approx 20's male PT lying supine, naked. B71/A74 performing CPR in the driveway outside of the PT's home, scene lighting was minimal, no shocks given, King LT device in place. Was told by personnel on scene that PT got into physical a altercation with SCSO and tased by SCSO before going into cardiac arrest. Officers performed CPR prior to SCFD 7 units arrival. During cardiac arrest PT had PEA, asystole rhythms. At no time was PT defibrillated.
Followed ACLS guidelines. Paramedic Sajon Lasalle from E31 assisted with ACLS guidelines and performed video ETT. PT's handcuffs were removed so that another IV could be established. During cardiac arrest, Calcium Gluconate and Sodium Bicarbonate given for consideration of excited delirium (Med Control Dr. Kirschner agreed to intervention). Dr. Kirschner consulted for termination of CPR efforts. He agreed since no change of rhythm (PEA and asystole) and long efforts of CPR given. CPR efforts terminated at 2302hrs.

Figure 3. Asystole and PEA documented by paramedic David Hanson.

Ofc. Block noted that Mr. Dold was nonresponsive to a sternal rub and had a faint or "weak" pulse consistent with PEA as reported at 22:08:34. It is important to note that many physician experts inappropriately confuse or conflate the faster-deterioration rate of ischemically-induced VF to the demonstrated longer duration for electrically-induced VF. The 2 are not synonymous as ischemically-induced VF tends to deteriorate more rapidly.[62]

Asystole and PEA are the most common cardiac arrest rhythms in deaths associated with drug and alcohol abuse.[63-68 69-71] Asystole and PEA are the most common cardiac arrest rhythms in deaths associated with excited delirium syndrome.[72-82] They are also very common with sudden death due to heart disease.[83]

Mr. Dold had the cardiac arrest rhythms of asystole (flat-line) and PEA which, with the limited time line, eliminates the possibility that he was electrocuted by the CEW.

5. Electronic Control is not More Dangerous with the Mentally Ill

The occasional opinion — that electronic control should not be used with the intoxicated (or mentally ill) — does not comport with the realities of law enforcement. That reality is that well-adjusted and sober members of society do not tend to be involved in forceful arrests as 79% of recipients of force have a history of mental illness or substance abuse and 66% have a documented history of mental illness.[84] More specifically to drug abuse, a large study found that 71% of electronic control subjects had drugs in their urine and 73% had a substance abuse history.[85] A large Canadian forceful-arrest study found that 82% of the subjects were being affected by alcohol, drugs, or emotional disturbance.[86]

The suggestion that CEWs not be used on the mentally ill (including those in excited delirium) or those intoxicated by drugs or alcohol would exclude the very people that most often resist being placed in custody. Also, prolonged continuous CEW exposure in the setting of acute alcohol intoxication has no clinically significant effect on subjects in terms of markers of metabolic acidosis. The acidosis seen is consistent with ethanol intoxication or moderate exertion."[87]

Sober and rational people generally do not resist law enforcement officers.

Materials Reviewed or Considered:

Pleadings:
Videos
CEW Download
Police Reports:
- Investigators Reports
- Officer Interviews

EMS Run Sheet

A Brief Primer on Electrocution.

Low-power electrocution is death from an electrical current from a source under 1000 watts (W).[88] This is contrasted from "high-power" electrocution from power lines or lightning strikes. The death is almost always the result of the electrical current inducing VF (ventricular fibrillation). The electrical induction of VF takes a few seconds at most.[39,40,42,89-97] (A massive electrical injury from a lightning strike or powerline can also cause death by nervous-system damage or kidney failure but that is not relevant here.) Modern CEWs fall in the "low-power" category. The TASER® CEWs all deliver ≤ 1.8 W.

In VF, the heart muscle cells continue to contract but at nearly random times. This is a common cause of cardiac arrest. Hence, there is no coordination among the cells and no blood is pumped from the heart. Loss of consciousness occurs in 13 ± 4 seconds if the person is supine (laying down).[53] If someone is standing or sitting then the collapse occurs within 1-5 seconds.[98,99] Also, the person loses their pulse immediately. Once VF is induced, there is no pulse. There are 6 primary diagnostic criteria required to diagnose an electrocution as shown in Table 8.

Table 8. Primary diagnostic criteria for electrocution.

#	Criterion	Timing
1	Sufficient current delivered to heart.	1-5 seconds of duration. [97] See Background section: *Electricity Does Not Build Up Like Poison.*
2	Loss of pulse.	Instant[100]
3	Loss of consciousness.	13 seconds if laying down.[53] 5 seconds if sitting up.[53,98,99]
4	Loss of normal breathing.	15-60 seconds.[100,101] Agonal breathing (typically 3 minutes) with a maximum of 6 minutes.[101-103]
5	Successful defibrillation.	14 minutes with any cardiopulmonary resuscitation (CPR); 9.5 minutes without.[104]
6	VF rhythm.	30-40 minutes after which the VF typically deteriorates to asystole or PEA.[60,105-108]

A final note on electrocution is that it is a stand-alone cause of death. Electrocution is not like a soup recipe where salt and pepper both contribute to the flavor. It does not "contribute" to other causes of death.[109] For example, if someone with late-stage cancer were to receive sufficient current, they would be dead within seconds and the cancer had nothing to do with it. However, if the same person received a lower level of current and died 30 days later, that person was not electrocuted. People have died as a result of falls from ladders after being startled by an electrical shock. The shock was certainly temporally related to the death, but this is not an electrocution as the fall from the ladder was secondary to the electrical shock. With rare partial exceptions — generally not salient to ARDs — the presence of other disease states does not make someone significantly harder or easier to electrocute. Conversely, low-power electrical currents do not hasten deaths from other diseases.

The CEW has an insignificant effect on a subject's adrenergic and metabolic state.[46,110-116] However, the effects of metabolic and adrenergic stress on the electrocution threshold have also been extensively studied. The effects, while statistically measurable, are immaterial in the ARD scenario. Adrenergic stress will temporarily lower the VF threshold (VFT) for a few minutes after which the VFT increases.[117,118] The impact for electrical weapons is that the critical dart-to-heart distance (DTH) could increase temporarily to 4-5 mm. Metabolic acidosis also has a similar immaterial effect.[119] Cocaine, a sodium channel blocker, *increases* the VFT and hence makes electrocution even more difficult.[120,121]

Blood has a typical resistivity of 150 Ω•cm and is thus the best electrical conductor in the body along with skeletal muscle (with the grain).[88,122,123]

Misunderstanding the Trigger-pull Download

A common error is to assume that the "TASER" data download in any way represents current delivery to the subject. It does not. It represents only an upper bound on the seconds of current discharged. The total time given by the download is typically 2-3 times what the actual total duration of current delivery was. This is theoretically harmless as the total duration of current is essentially irrelevant to diagnostics since electricity does not build up like poison. Thus, the most exaggerated figures are often the least relevant. However, novice CEW "experts" often stress the total trigger-pull time so it should be addressed.

A TASER download printout showing trigger pull times with a total of, say, 100 seconds provides the following information:

- The times of the trigger pulls (after clock-drift correction).
- The number of seconds of current delivery is 0-100. I.e. somewhere between 0 and 100 seconds.

As an example, in the tragic death of the methamphetamine addict, Robert Heston, (who attacked his father and father's home) there were a total of 206 seconds of trigger-pulls on 5 M26™ CEWs and 6 deployed cartridges used to attempt to control him.[124] A careful analysis found that the actual duration of current delivery was 5-9 seconds. Here the exaggeration was at least 20:1. In a non-USA case (unnamed here due to confidentiality restrictions) there was a total of 154 seconds of trigger-pull duration from 28 trigger pulls. Each CEW had a camera attached and thus the actual duration of current delivery could be determined from an audio analysis.[125] There was a total of only 20 seconds of current delivered.

U.S. Federal Appeals Court decisions recognize that trigger pull records do not equate to delivered current. See *Hoyt v. Cooks*, 672 F.3d 972, 976 (11th Cir. 2012)("The record shows that an 'activation' of the Taser does not mean that the Taser actually touched or stunned Allen."). See also *Bussey-Morice v. Gomez*, 587 F. App'x 621, 625 (11th Cir. 2014):

> the report further notes that in order for energy to be transferred from the Taser via the probes, contact must be made with the individual by both probes to complete the circuit…The TASER log shows only device activation; it does not represent that a shock was actually delivered to a body nor does it distinguish between probe deployment and drive stun.

Causes of Current Delivery Exaggeration:

1. Broken wires or dislodged probes
2. Rounding up to the next second
3. Muzzle contact canting with drive-stuns
4. Muzzle contact and release delays
5. Inadvertent trigger pulls

Broken Wires or Dislodged Darts

A significant reason for multiple or prolonged CEW trigger pulls is that the fragile wires are broken early in the encounter and the officer continues to pull the trigger, hoping for a restraint-helpful response from the subject.

The tiny wires (36 gauge, 127 microns in diameter) are about the diameter of some human hair and are usually quickly broken during any struggle and are typically broken when a subject turns, falls, or flails his arms. The tensile strength, of the wires, is weaker (less than 1 kg) than the weakest fishing line (2 kg or 4 lbs breaking test) and are thus very easily snapped.[126] In fact, in some instances prisoners now teach other inmates that they should roll over if they receive a CEW discharge, in order to break the wires.

Probes are also often lodged in the clothing instead of the skin.

Rounding Up to the Next Second

The reported trigger-pull durations, in the TASER CEW download reports, are rounded up from the first 1/100 of a second. I.e. if the actual duration was 2.01 seconds then it is reported in the download as 3 seconds. Thus, the best estimate of the actual trigger pull is ½ second less than what is reported. Automatic duration trigger pulls of 5 seconds are, in fact, 5.00 seconds and thus there is less risk of an interpretation error there. This is irrelevant with the Trilogy "Pulse-logs" which give trigger pull and arc-switch durations to the nearest 0.1 second, and report each pulse.

Muzzle Contact Canting with Drive-stuns

As seen in Figure 4, an effective drive-stun application requires that the CEW muzzle be kept nearly perpendicular to the body surface. This can be difficult to do with a moving subject. A non-analgized non-anesthetized subject will reflexively pull or roll away from the attempted shock. On average, a good contact is only made about 30% of the time. If the muzzle is canted up to 20° away from perpendicular, then an arcing connection can still be made. The typical correction is to subtract 70% from the download times.

Muzzle Contact and Release Delays

With a drive-stun the officer will typically pull the trigger as the muzzle is being brought down towards the subject. The results in the trigger-pull duration overstating the current delivery by about ½ second. If the officer is delivering a drive-stun of less than 5 seconds, they will usually need to pull the weapon back to more easily activate the safety and this release delay also results in the trigger-pull duration overstating the current delivery by about ½ second. In total, the contact and release delays add about 1 second to the actual current delivery time for drive-stuns.

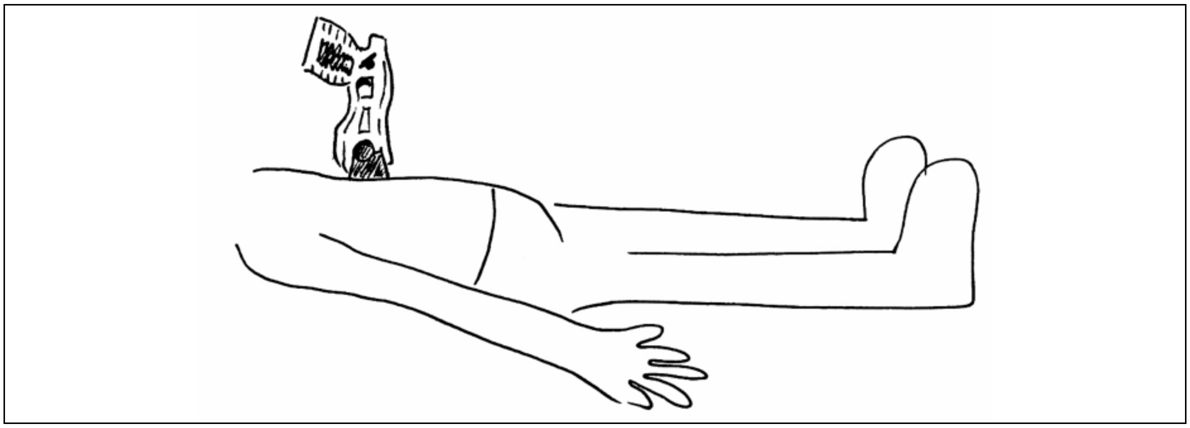

Figure 4. The drive-stun requires that the CEW muzzle be kept nearly perpendicular.

Inadvertent Trigger Pulls

Background:

The inadvertent trigger pull (ITP) has been well studied for firearms discharges.[127,128] According to Heim there appear to be 3 primary causes:[127]

1. sudden loss of balance;
2. contractions in the hand holding the weapon while other limbs are in use, for example during a struggle with a suspect;
3. startle reaction.

Common to every incident, in addition to the weapon being held in a hand, is that all limbs appear to be involved in the resulting sudden movement.[127] Recent work by the Lewinski group found no cases of firearm ITPs involving startle.[129] We have also not seen situations where a startle reaction led to a CEW ITP and thus we will focus on #1 and #2 above. Another potential cause is the *fist* reflex which is natural from birth and can be reinforced by training with closed-hand strikes; this can occur in a high stress confrontational situation.[130,131] The fist reflex may not apply to CEW ITPs and will not be discussed further here.

Physiology:

It has been recognized for over 100 years that muscle contractions in any limb can lead to increased activity in other limbs.[132] This has generally been referred to as *motor overflow* or *overflow activity*.[133,134] This is especially seen in opposite (contralateral) limbs where the phenomenon is referred to as *mirror movement*.[135-138]

When we contract a *single* hand firmly we also *invariably* contract the opposite hand somewhat.[139] Typical male grip strength is 130 ± 16 pounds where 25- 42% is exerted by the index finger.[140] Overflow activity can reach a maximum of 25% of the maximum voluntary force of the individual limb.[141] Thus, forces of up to 14 pounds (= 25% • 42% • 130 lbs.) can be involuntarily exerted by the index finger.[127] This is sufficient to overcome the trigger pull (8-

12 lbs.) for the 1st round of an uncocked double-action pistol. Even when warned to keep their fingers off of the trigger — and knowing that they were being studied — 21% of officers contacted the trigger for > 1 second in stress simulations.[127] When studied with their index finger already on the trigger, 28% (=7/25) of volunteers gave involuntary trigger pulls of > 14 lbs. when they either pulled with their opposite arm or lost their balance.[127]

Effect of Officer Age:

Shinohara studied the contralateral hand contraction in 10 young (18-32 yo) and 10 old (66-80 yo) right-handed subjects.[173] For young people, the contralateral force was greater when the right (dominant) hand was voluntarily activated. For old people, there was no statistically significant difference between the hands. As seen in Table 4, the strongest mirror index finger force was in older subjects; the weakest was in the right hand of the young subjects. Due to the mechanical restrictions imposed on both hands, the MVC (Maximum Voluntary Contraction) was < 20% of what can be measured on an unrestricted hand and arm.[174] Force is given in newtons (N).

Table 9. Shinohara contralateral index finger contractions.

Subjects	Hand	MVC (N)	Involuntary	Involuntary
Young	Right	25.8	4.7%	1.21
Young	Left	25.5	9.1%	2.33
Old	Right	29.9	13.8%	4.13
Old	Left	27.6	11.4%	3.15

Shinohara concluded, "The results indicate that old subjects have a reduced ability to suppress unintended contralateral activity." This is clearly seen in Figure 5.

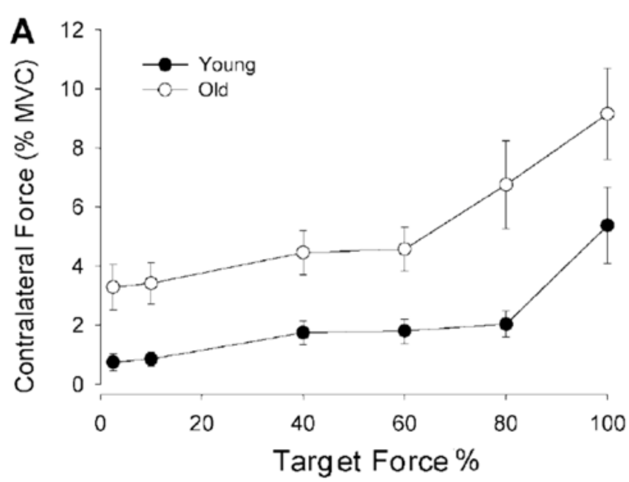

Figure 5. Shinohara study showing increased contralateral activity in older subjects.

The combination of involuntary muscle contraction activity and a finger on the trigger (which was either unconsciously pre-positioned or moved with the involuntary activity) is responsible for many inadvertent firearm discharges by law enforcement officers.[128,129,142]

Comparison to Firearms:

With the conducted electrical weapon (CEW), the incidence of ITPs is far greater — than with firearms — for 2 primary reasons:

1. The CEW trigger pull is far less at only 2 lbs. for the popular X26 (X26E) CEW and 3 lbs for the X2 CEW. The trigger is thus 3-6 times more sensitive than that of an uncocked double-action pistol.
2. Officers commonly hold the CEW in their dominant hand and attempt to assist with subject control or lifting with the other hand. They would never do this with a firearm as it is forbidden by weapons retention training.

Ironically, the situation is both far worse but also far better for the CEW compared to the firearm. While a CEW operator will have far more ITPs, the results are almost always harmless compared to the often-fatal consequences of a firearm ITP.

The Harm of the Helping Hand:

A major cause of mirror-movement ITPs is an officer trying to help control a subject with the non-dominant hand while keeping the CEW in the dominant hand. In a helping hand scenario, at least 2/3 of the trigger pulls are ITPs.

We have investigated many incidents in which the *majority* of trigger pulls appear to be ITPs. In the typical case the officer is maintaining his grip on the weapon while trying to restrain the subject with the free hand and possibly also the CEW-constrained hand. This can also occur while holstering the weapon if the opposite hand is being engaged in the struggle. Thus, during a physical struggle with the CEW in an officer's hand, most of the CEW discharges tend to be mirror-movement ITPs which then run the full standard default 5 seconds or until, or if, the officer realizes what is happening (from the arcing sound) and turns the weapon OFF (safety ON). In many cases, the arcing sound is not noticed because of the yelling, environmental noise, or the focus on a struggle.

Incidents with multiple (>3) trigger pulls and full documentation (Trilogy pulse-logs and body-cameras) have been analyzed to determine the relationship between the trigger pull time-totals and the actual seconds of current delivered. The interesting finding is that the actual seconds of current begins to level off at 10-15 s so the percentage of time continues to decrease from ~35% down to as low as 5%.

Most of the CEW ITPs occur with drive-stuns which are well established as having no deleterious effects outside of short-term minor contact burns.[143-]

[145] Moreover, the inadvertent drive-stun trigger pull is almost always with the weapon far away from the subject as the officer's opposite hand is the one in contact with the subject. For the minority of cases that began as a probe-mode deployment, the connection has usually been broken by the grounding, attempted restraint, or ground struggle. If a full probe connection was still existing, then there would be far less need for manual control and hence a low likelihood of an ITP.

Forensic Evidence

After 2 seconds of drive-stunning through clothing, small sunburn-like marks will be left. A drive-stun leaves a pair of distinctive marks due to the 40 mm fixed distance between the muzzle electrodes.[145] This is depicted in Figure 6.

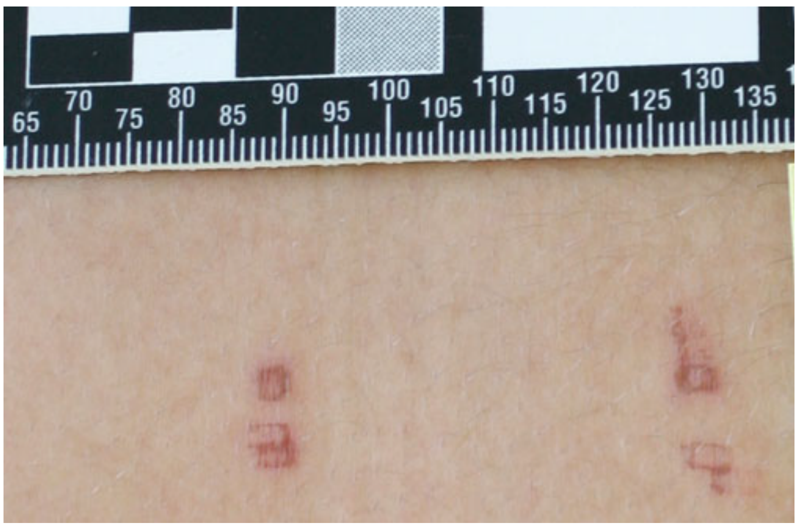

Figure 6. Drive-stun marks.

For probe-mode applications, microscopic analysis of the "eye of the needle" in the back of the probe can estimate the duration of the current delivery.[146,147]

The newer model CEWs, X2, X26P, and T7 allow the duration determination from the enhanced "Pulse Log" download.

The Significance of the Sound

The X26E CEW is fairly quiet at 51 decibels (dBA) @ 1 meter, when it has a completed circuit connection. The X26E is much louder when it is arcing and *not* completing a circuit (79 dBA @ 1 m). This is like many devices that are quiet when working properly and louder when not. Sound levels from ordinary sources as seen in Table 10.

The scientific basis of the crackling sound emitted from an electrical arc has been well studied.[148-150] This distinction is also known to CEW-trained law enforcement officers, and easily demonstrated in many ways such as arcing to a soda can or across the CEW muzzle.

Table 10. Sampling of sound levels from various sources.

Sound level (dBA @ 1 m)	Source
90	Train whistle (@ 150 m)
79	X26E CEW open-circuit crackling
70	vacuum cleaner
60	polite conversational speech
51	X26E CEW closed-circuit clicking
50	average home volume, normal refrigerator
40	quiet library
30	quiet bedroom at night

There is indeed a dramatic difference between the open circuit arcing and intact circuit sound level. When the X26E CEW is deployed with a completed circuit (such as contacting a body) it makes a relatively soft clicking noise which is softer than normal conversation and on the order of the sound from a properly operating refrigerator. However, in the open-circuit mode — such as when a wire is broken, a probe misses, there is a clothing disconnect, intermittent disconnect, or a probe is dislodged — the sound level is 79 dBA which is well above that of a vacuum cleaner. The difference between 51 dBA and 79 dBA is logarithmic and actually corresponds to a ratio of:

$$\begin{aligned} \text{Ratio} &= 10^{((79-51)/10)} \\ &= 10^{2.8} \\ &= 631 \end{aligned}$$

Thus, the X26E CEW in arcing mode has 631 times the sound *intensity*. This arcing sound is heard with a spark test. With a closed circuit (good connection) the sound cannot be easily heard over loud conversation and generally not over yelling and shouting. The arcing (open-circuit) sound is not only much louder but has a *different* sound. It is often described as a "crackling" sound as opposed to a "clicking" sound. The "crackling" sound is so different that it can be

easily differentiated by zooming in on the sound recording as depicted in Figure 7. The top tracing is the instantaneous sound level of an X26E CEW that is arcing (at the muzzle) while the lower tracing is of an X26E CEW with an intact circuit. Note that 3 pulses are shown in each tracing. The X26E CEW discharges at a pulse rate of ≈ 18.3 PPS (Pulses Per Second) so the pulses are about 55 ms (milliseconds) apart. Note that the top (arcing) tracing intuitively appears "noisier" — which it is. The lower tracing of the connected intact completed circuit "clicking" sounds shows that they are much "cleaner."

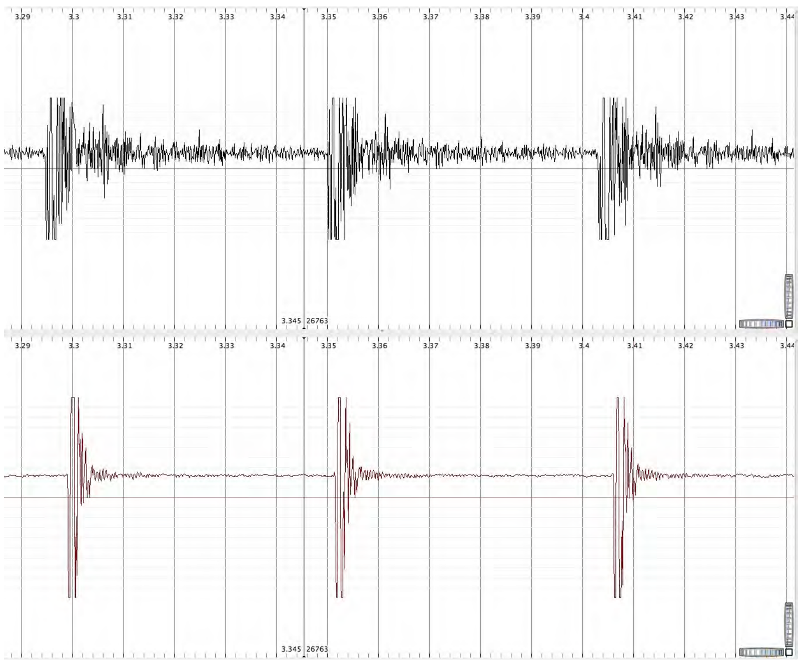

Figure 7. X26E CEW sound signatures of open circuit and closed circuit pulses.

The excursions of the sound level signal saturate the TASER CAM storage until the AGC (Automatic Gain Control) can automatically "lower the volume." That is why the louder crackling sound actually appears shorter in height. For a good connection, these excursions last about 2 ms as seen in the lower trace. For arcing, these excursions last ≈ 4 ms as seen in the upper trace.

General Background:

A. The Electrophobia Myth

Many people have an illogical emotional fear of electricity or *electrophobia*. From an early age in life it is drilled into young children that 110 V (volt) electrical outlets cause death, Thus, most people have deeply absorbed the urban myths that voltage itself is dangerous and 110 V causes death. While most people learned to dispel this myth in middle-school sciences classes it is often forgotten by adulthood. While this is scientifically incorrect most people, including most media, hold these myths to be undeniable truths.

Life itself could not exist without electricity. Trying to say that all electricity is dangerous is equivalent to saying that all balls are dangerous. There are marked differences in the effects of being struck by a ping-pong ball, baseball, bowling ball, and wrecking ball.

Table 11. AC Currents and Their Typical Effects

AC Current (mA)	Effect
1500	Nerve Damage
1000	
500	Cardiac Arrest Probable
200	
100	Cardiac Arrest Possible
50	Interference w Breathing
18	TASER ® Weapon (AC Equivalent)
16	Male No-let-go threshold
10	Muscle Contractions Begin
5	Pain Sensation
1.1	Male Hand Perception
0.7	Female Hand Perception

The typical effects of various AC currents are shown in Table 11. The < 2 mA of pulsed DC current (for the TASER® CEWs) is not directly comparable so a 18 mA AC equivalent is used.[151]

B. CEW Probe Mode

In probe mode, the TASER® handheld CEW uses compressed nitrogen to deploy 2 small probes at typical distances of up to 7.7 m (meters) or 25 feet.[152,153] (Other cartridge models can reach a distance of 11 m or 35 feet.) When the CEW trigger is pulled, the high voltage pulse first serves to activate a primer which opens the nitrogen cartridges to release the nitrogen to propel the probes as directed. These probes themselves are designed to pierce or become lodged in most light clothing (and to complete the circuit with the 50 kV arcing capability). The sharp portion of the probe is 9-13 mm (millimeters) long

and will typically penetrate the epidermis and dermis to a depth of ~6 mm for a good electrical connection.

The ultra-short duration electrical pulses applied by TASER CEWs are intended to stimulate Type A-α motor neurons, which are the nerves that control skeletal muscle contraction, but without a high-risk of stimulating cardiac muscle. This typically leads to a loss of regional muscle control and a fall to the ground to end a violent confrontation or suicide attempt.

Small swine of 30 kg (65 lbs) can be put into VF when the CEW probes are put within a few mm of the heart. [29,154] One study used a custom long plunging probe to deliver the CEW current almost directly (within 6 mm) to the heart of a pig in order to induce VF.[155] There are numerous problems with the swine model that significantly exaggerate the electrocution risk. [154,156] Pigs are extremely sensitive to electrical currents due to their hearts being literally wired "outside-in" compared to a human's (being wired "inside-out").[157-162] The swine heart needs 2/3 less current to induce VF (ventricular fibrillation) compared to the human heart from external stimulation. In other words, the swine is 3 times as sensitive to electrocution as is the human.[163] This CEW-electrocution effect is also confined to *small* swine.[34] In stark contrast, human studies consistently demonstrate no risk of VF with a CEW application.[164-168]

This is clearly the consensus of the scientific and medical community as shown by various position papers. For example: the June 2009 American Medical Association (AMA) White (Position) Paper concluded:[169]

> Furthermore, no evidence of dysrhythmia or myocardial ischemia is apparent, even when the barbs are positioned on the thorax and cardiac apex.

On May 24, 2011, the National Institute of Justice, after a 5-year panel review, concluded:[170]

> Current research does not support a substantially increased risk of cardiac arrhythmia in field situations, even if the CED darts strike the front of the chest. There is currently no medical evidence that CEDs pose a significant risk for induced cardiac dysrhythmia in humans when deployed reasonably.

Finally, in June 2012, Bozeman stated:[167]

> The risk of such dysrhythmias, even in the presence of a transcardiac CEW discharge, is low, and suggest that policies restricting anterior thoracic discharges of CEWs based on cardiac safety concerns are unnecessary.

No danger or harm has been associated with the CEW probe-mode application, in human studies.

C. CEW Drive Stun Mode: Skin Rub vs. Injection

Alternatively, the CEW may be used in a "drive-stun" mode by pushing the front of the weapon into the skin to function as a higher charge stun-gun. With the fixed electrodes, only 4 cm (centimeters) or 1.6 inches apart — and the lack

of skin penetration — the current flow is primarily through the dermis and fat layer between the electrodes and there is no significant penetration beyond the subdermal (or subcutaneous) fat layer. See Figure 8. Since there is insufficient depth of current flow to capture muscles, the drive-stun mode serves only as a compliance technique. To make an analogy to medicine, drive-stun is like rubbing an ointment on the skin compared to the probe mode, which is like an injection. They have significantly different effects.

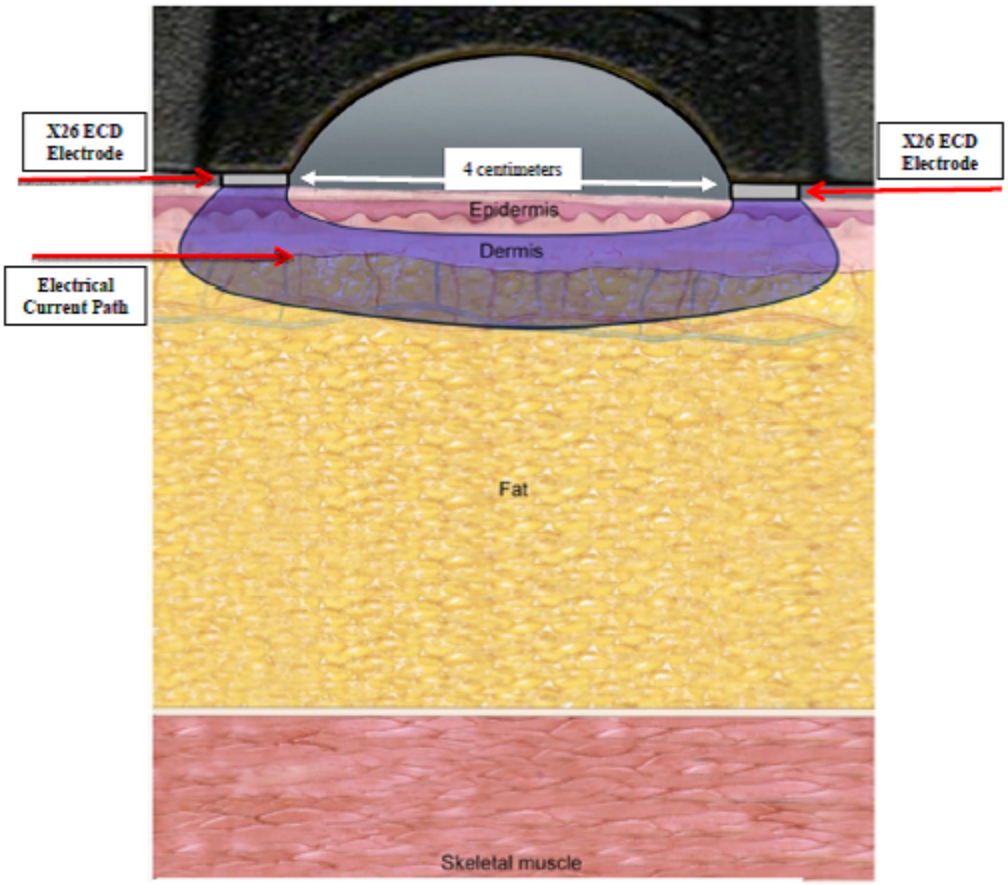

Figure 8. The majority of the drive-stun current is confined to the fat and dermis layer.

As mentioned above, small swine (30 kg or 65 lbs) can occasionally be put into VF when fully-embedded CEW *probes* are nearly touching the heart.[171,172] *However, it is impossible to fibrillate even small swine with a transcutaneous CEW drive-stun application.*[173-176] The electrical current simply does not penetrate deeply enough to affect any human muscles or organs. In fact, with a CEW drive-stun application directly over the human phrenic nerves (the nerves that control breathing) there is no effect.[177]

The National Institute of Justice, 5-year study of CEWs, found:[170]

> Risk of ventricular dysrhythmias is exceedingly low in the drive-stun mode of CEDs because the density of the current in the tissue is much lower in this mode.

The American Academy of Emergency Medicine (AAEM) has the following guideline on drive-stun applications:[178]

> For patients who have undergone drive stun or touch stun ECD exposure, medical screening should focus on local skin effects at the exposure site, which may include local skin irritation or minor contact Allen. This recommendation is based on a literature review in which thousands of volunteers and individuals in police custody have had drive stun ECDs used with no untoward effects beyond local skin effects.

The Federal Court of Appeals for the 9th Circuit [*Brooks v Seattle*], and others, have concluded:

> The [TASER CEW]'s use in "touch" or "drive-stun" ... involves touching the [TASER CEW] to the body and causes temporary, localized pain only. ... this usage was considered a Level 1 tactic, akin to "pain compliance applied through the use of distraction, counter-joint holds, hair control holds, [and pepper spray]" and used to control passively or actively resisting suspects.

CEW drive-stun applications have no clinically significant physiological or pathological effects.

D. Current Flow in the Body

The flow of electrical current in the body is well understood and has been the subject of 100's of scientific papers.[50,179-187] The simplest analogy is the 1st to 2nd baseline in baseball. See Figure 9. The runners can go directly between the bases but they typically curve out a bit. Similarly, with 2 electrodes in the skin, the current flow "dives" in somewhat just like a runner's path in baseball. The further the electrodes are apart, the deeper the "dive" of the current. This analysis is accurate for a homogenous conductor like saltwater or fat. However, the body's skeletal muscle layer preferably directs current around the outside of the body since electrical current vastly prefers to follow the grain of the muscle instead of going transverse and penetrating the body.

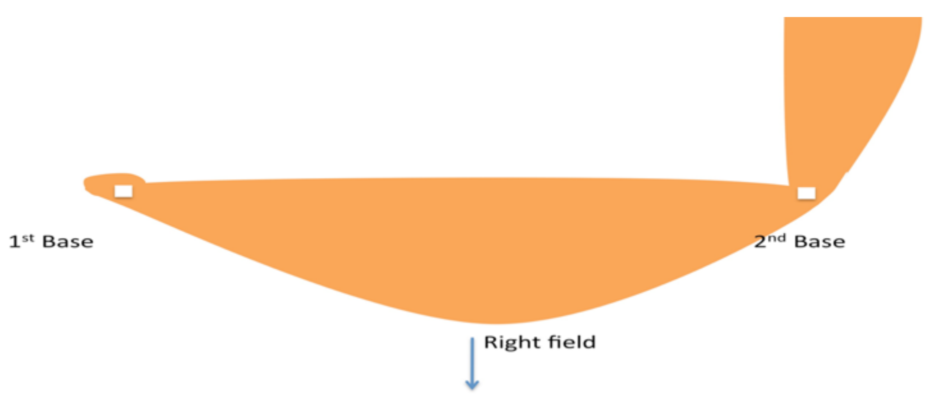

Figure 9. Graphic of electrical current flow in the body analogized to baseball.

Some medical examiners have wrongly opined that since they witnessed a subject experience board-like lockup induced by a CEW that the current flows everywhere even inside the body.

A runner might deviate somewhat from a straight line but would never run out into the outfield or wander into the bleachers. Similarly, with 2 CEW electrodes on the chest, no current passes into the legs or brain. That would be like a runner going into the outfield and then climbing up into the seats and then back to 2^{nd} base.

An important exception occurs around bone. Mature calcified bone is an insulator and can thus not conduct electrical current.[188] A CEW probe landing in the sternum will pass very little current. What current is passed will be defused around the surface of the chest and will tend to not affect the heart even though parts of the heart are directly beneath the sternum.[179,189]

Electrical current in the body tends to follow muscle fiber and only deviates slightly.

E. CEW Comparison to Other Nerve Stimulators

TASER CEWs deliver less current than typical models of EMS (Electrical Muscle Stimulator) units. It is very popular in Europe to use TENS (Transcutaneous Electronic Nerve Stimulator) units for treating angina with the electrodes placed across the cardiac silhouette.[190-192] No deaths have been reported.

Figure 10. Electrical muscle stimulation is widely used for muscle training.

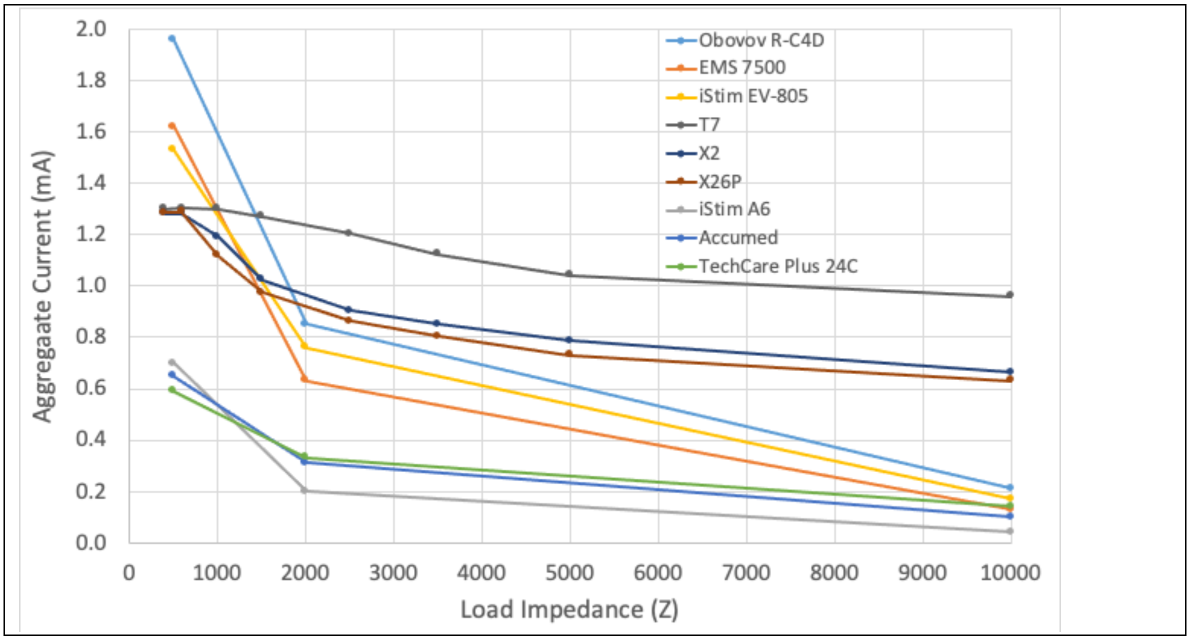

Figure 11. Aggregate current vs. load impedance.

The outputs of the TENS and EMS units are compared with the electrical-weapon muscle stimulators as seen in Figure 11. In the typical impedance range of around 500 Ω, the EMS units delivered the most current followed by the CEWs (T7, X2, and X26P).[193]

Figure 12. Subject using Miha Bodytec system.

Whole body electro-myostimulation (WB-EMS) is an new extreme athletic training technique that recently originated in Germany with a device called the Miha Boytec.[194] The subject strips naked and then dons the electrode jacket as shown in Figure 12 and Figure 13. Additional electrodes are placed on the legs.

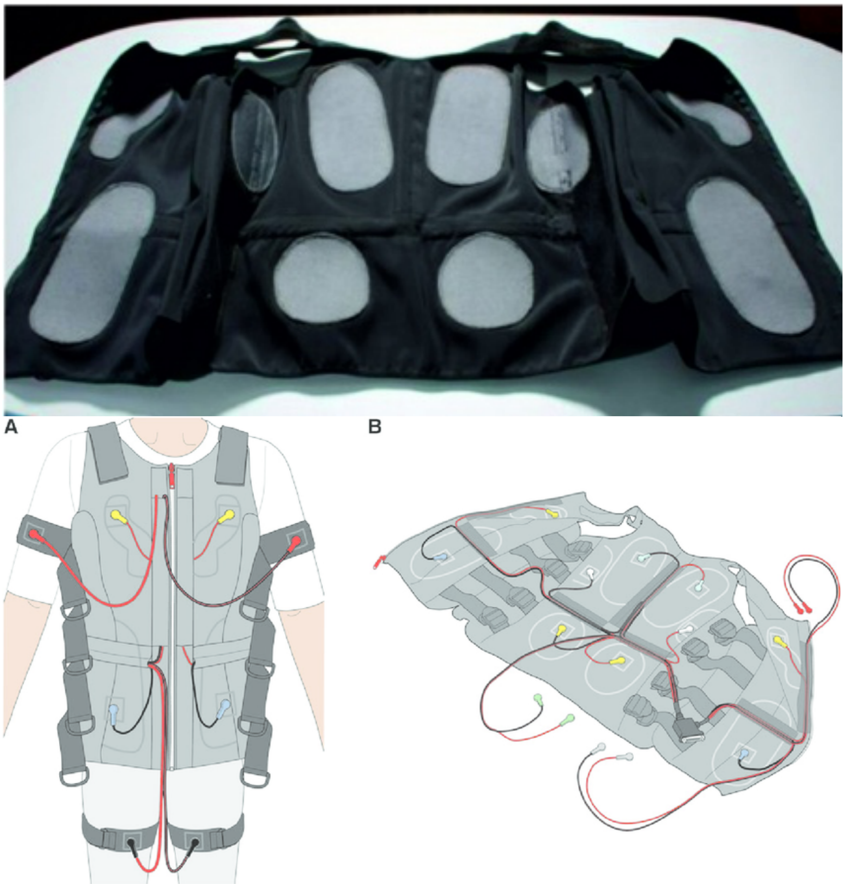

Figure 13. Miha Bodytec WB-EMS electrode vest.

Table 12. Comparison of X26 CEW to the Bodytec system.

	TASER® X2 CEW	Miha Bodytec
Electrodes/Channels	4/2	20/10
Pulse rate (per second)	19.6	2-150
Pulse duration (μs)	71	50-400
Typical duration (s)	10	1200
Pulse charge (μC)	65	< 32
Aggregate current (mA)	1.3	< 4.8
Aggregate current over all electrodes/channels (mA)	2.6	< 48

As seen in Table 12, there is a world of difference between the level of stimulation between an X26 CEW and the Miha Bodytec WB_EMS system. The Bodytec delivers more current per electrode pair and over 10 times the total current to the body.[193]

F. ANSI CPLSO-17 Standard

All present TASER brand electrical weapon outputs exceed the minimum requirements for effectiveness under the ANSI CPLSO-17 standard. These output

levels are also below the maximum safety limits under the ANSI CPLSO-17 standard of 2.2 mA.

G. CEW Comparison to the Electric Fence

It is helpful to discuss the most common and longest existing electronic control device — which controls humans and other mammals by giving short painful electrical stimuli — namely the electric fence.

The IEC (International Electrotechnical Commission)and UL (Underwriters Laboratories) have long had standards for electric fences.[9,10] These are the Particular Requirements for Electric Fence Energizers. IEC 60335-2-76, edn 2.1, and the UL Standard for Electric-Fence Controllers in: Laboratories U, ed. UL 69. Independent testing has verified that the TASER X26E CEW satisfies both the IEC and UL electric fence standards.[5] The X2 and the X26P CEWs also satisfy these standards.[6]

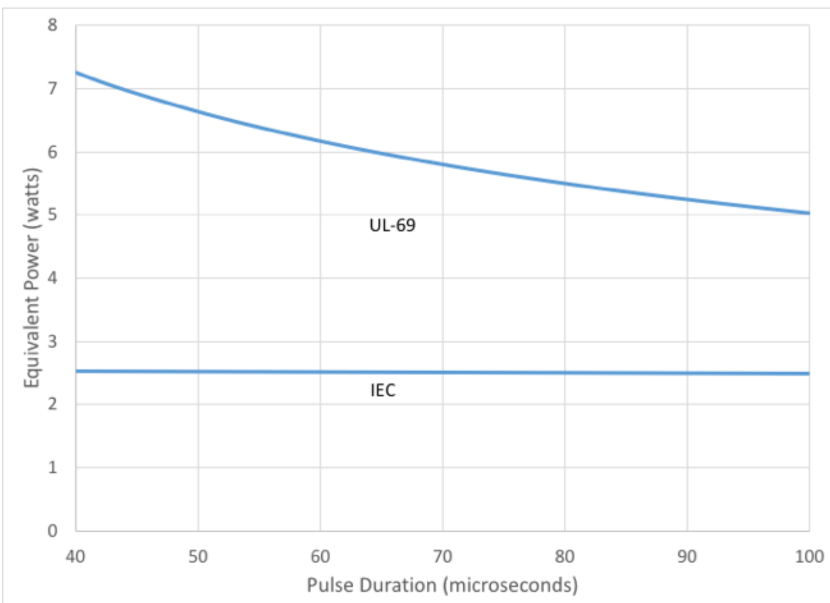

Figure 14. UL 69 electric fence equivalent power safety limit.

The X26 CEW satisfies the electric fence standards by a very wide margin.[5] The conservative IEC standard allows up to 2.5 watts (W) for an electric fence and all present TASER CEWs deliver <1.8 W. The UL high-rate limits are found in section in 23.2.4 of the UL standard 69.[10] This limit is shown in Figure 14 which allows 5 W for the wider-pulse X26 CEW and 6 W for the narrow-pulse X2 CEW. The electric fence standards have evolved from almost 100 years of experience with documented fatalities from earlier high-powered devices. The UL carefully collected data on these units to find out what was a safe limit. The typical accidental exposure to an electric fence is based on someone walking into it and thus is a frontal exposure. Depending upon the relative heights of the fence and the individual this exposure could be anywhere from the face to the thighs

and could include skin penetration from barbs on barbed wire. These limits are very stringent and now fatalities from electric fences are almost unheard of in spite of there being on the order of 100,000 miles of electric fence in the United States alone.

The TASER X26 CEW satisfies the International and UL electric fence standards by a wide margin and can be thus deemed very safe.

H. Comparison to General International Safety Standards

The IEC has set 40 mA AC as a safe level of utility (50/60 Hz) electrical current for avoiding the risk of VF induction (electrocution).[9,39] Rapid short-pulse stimulation has the same risk of VF induction as does utility power frequencies at a current of 9 times higher than the average current of the rapid pulses. The *TASER X26E CEW* delivers about 18 pulses per second at a charge of about 100 μC (microcoulombs) per pulse.[195] This gives an average current of 1.8 mA which corresponds to a utility power current of 16 mA. This is seen to be less than 1/2 of the IEC VF safety level.

The TASER X2 and X26P CEWs delivers about 19 pulses per second at a charge of about 63 μC (microcoulombs) per pulse.[195] This gives an average current of 1.18 mA which corresponds to a utility power current of 10.6 mA = 1.18 mA • 9.0. This is seen to be less than 1/4 of the IEC VF safety level. The TASER X26E, X2, and X26P CEWs satisfy all relevant international electrical safety standards.[6,8]

The available TASER CEWs satisfy all relevant electrical safety standards.

I. Electricity Does Not Build Up Like Poison: Baseball vs. Science

It is often alleged that multiple CEW applications are somehow more dangerous than a single standard 5-second CEW application. This can seem to be very intuitively appealing as multiple baton strikes and multiple bullet wounds are more dangerous than single ones. This intuition is, however, completely wrong and contrary to decades of scientific research. Due to the prevalence of this false intuition — even among some clinicians and pathologists — it is helpful to present a fairly lengthy discussion of the scientific facts below.

In fact, 1 second is the official implied value used by UL for their electrical safety standards. [97] The IEC uses a more gradual transition out to about 3 seconds as seen in Figure 15. Note that the UL has a slightly stricter safety limit for VF than does the IEC but that is not relevant to this discussion.

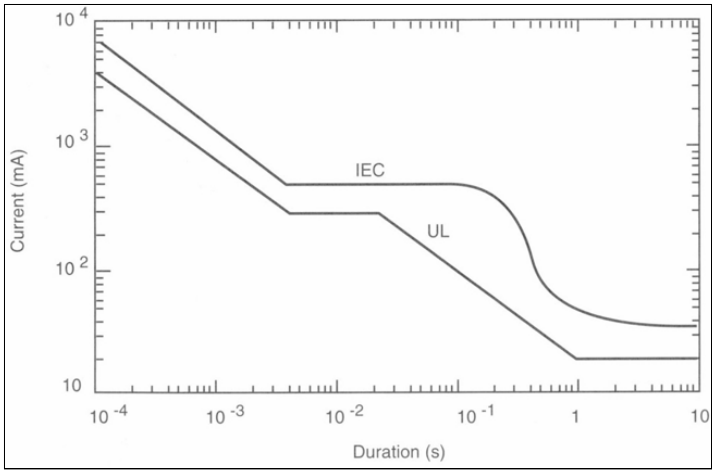

Figure 15. UL and IEC standards recognize that VF is induced or not within 1-5 seconds.

These standards are supported by numerous animal and human studies. The "transition time" is the number of seconds after which VF is either induced or not induced with a certain level of electrical current. A summary of studies of the transition time is given in Table 13.

Table 13. VF transition times from various studies

Author	Model	Transition Time (seconds)
Antoni[90]	guinea pig	0.8
Wegria[91]	exposed dog hearts	0.2
Ferris[92]	sheep	1.4
Jacobsen[93]	swine	4.0
Roy[94]	dog	2.0
Scott[42]	dog	< 3.0
Kiselev[96]	dog	< 5.0

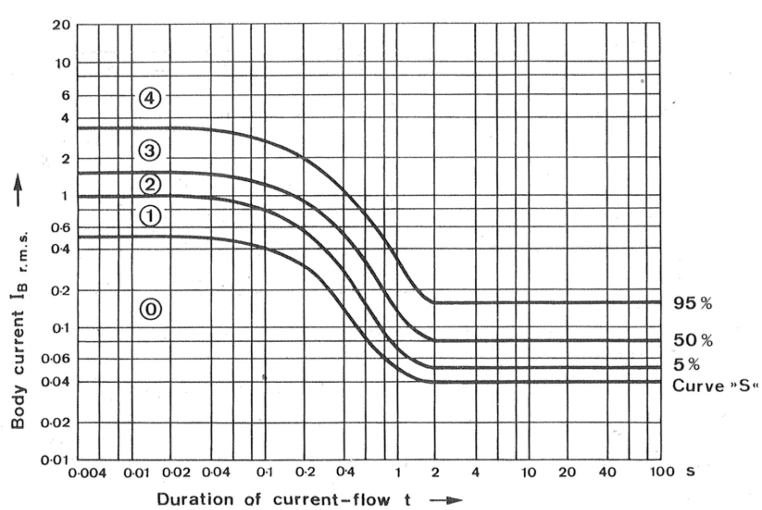

Figure 16. Original Biegelmeier curves showing safe (S) currents for humans.

Using calculations based on the human heart rate, Biegelmeir and Lee determined that the transition time for humans is 2-5 seconds.[39,40] See Figure 16. In a human study, Swerdlow et al showed that the VFT decreased by 47% with durations going from 1-5 seconds, consistent with the calculations of Biegelmeier.[95]

In a canine study, Scott et al found that the VFT did not change with durations going from 3 out to 60 seconds.[42] Kiselev also found the VFT to be quite constant from 5 to 30 seconds.[96] Scott states in his conclusions:

> Shocks of 3, 10, 30, and 60 seconds duration produced very similar mean [VFT] values. The stability of mean [VFT] over this wide range of shock duration suggests a basal threshold of fibrillation. Currents below this threshold seem unable to induce fibrillation regardless of shock duration.[42]

Scott's study showed that nothing happens between 3 and 60-second applications of current. Importantly he did this study in 16 canines, which have hearts that are electrically similar to humans — unlike pigs.[196-200]

The Dogma Of 3 Strikes And 15 Seconds.

While anesthetized animals have been tested up to 30 minutes, human CEW testing has to be performed on volunteers. Law-enforcement trainees are often required to take a 5-second CEW exposure but it is very difficult to find volunteers willing to expose themselves to more than 10 or 15 seconds. Therefore, most clinical trials of the physiological effects of the TASER CEW, involve exposures of 5, 10, or 15 seconds. For example, there are a number of studies with continuous 15-second exposures.[201-204]

The independent review of Pasquier found:

> According to the available results, the physiologic changes from electronic control device exposure appear to be safe in healthy individuals who undergo an exposure duration of 5 to 15 seconds, i.e., the duration that corresponds to the majority of field exposures."[205]

Importantly, these clinical studies failed to find any trends for increased effects between 5, 10, and 15 seconds so there has been no evidence to motivate longer-duration studies. Dawes observed, "… the duration of the exposure does not appear to have a significant effect on CK [creatine kinase]."[206]

There is certainly a false lay-intuition that electrical charge must build up like poison since baton strikes and bullet wounds do tend to injure in a cumulative fashion. However, over 100 years of electrical research has demonstrated that the direct effects of electricity do not build up like poison. Specifically, the US military has tested this in swine with continuous CEW exposures across the whole chest up to 30 minutes — not 30 seconds.[38] If someone is electrocuted this generally occurs within 1 second with an upper limit of about 2-5 seconds.[39,40] If an electrical current is strong enough to kill someone it will do so in

the first few seconds of exposure and a longer exposure duration simply has no additional effect. With a full-trunk human exposure, there is a slight pH shift (blood becomes less alkaline) in the first few seconds but then does not change.[111,113,115,116,207-211] For a given degree of subject resistance, the more the CEW is used, the better the outcome will tend to be since the use of more conventional force control options can be reduced. [1,212-216]

The epidemiological data unambiguously finds no increased risk with CEW exposures beyond 15 seconds:

1. Brewer studied 292 arrest-related-deaths (ARDs) where a CEW had been used.[13] He found that: (1) over 75% of the 292 deaths involved only 1 or 2 CEW exposures, (2) 85% of fatalities were preceded by 3 CEW exposures or less, and (3) concluded that there was no correlation between the number of CEW exposures and the mortality rate.

2. White studied 188 ARDs where a CEW had been used and similarly found that 87% of them had 3 trigger pulls or less which is the equivalent of 15 seconds of discharge or less.[217]

The widespread dogmatic urban myth that 15 seconds is safe while 16 seconds is dangerous is contradicted by all of the relevant scientific studies and statistics.

The direct electrical induction of VF by electrical currents takes 1-5 seconds.

J. The Handheld CEW Has Led to Dramatic Reductions in Injury.

Numerous published studies have now clearly demonstrated substantial injury and fatality reductions from the use of TASER CEWs compared to alternative control techniques.[1,85,218-223]

A partial list of these studies includes:

1. Bozeman comparison to other force options, including physical force.
2. MacDonald which compared the CEW to pepper spray and "physical force."[1]
3. Taylor which compared the CEW to pepper spray, baton strikes, and "hands-on."[2]
4. Mesloh who studied CEW usage in comparison to many control options.[213,219]
   a. Gentle hold
   b. Handcuff
   c. Leg restraints
   d. Pepper spray
   e. Compliance holds
   f. Takedown
   g. Empty hand strike

h. FN303/Pepperball
i. Impact weapon
j. Canine

The largest epidemiological study was the 2009 MacDonald study of 24,380 uses of force.[1] This study found that CEW usage dramatically reduced both subject and officer injury (by 2/3) compared to alternative force options. Additional studies demonstrating injury reduction are memorialized in the papers of Taylor (13,983 subjects)[2], Mesloh (n = 4303)[219], Smith (n = 1645)[214], Butler (n = 562)[215], White (n = 243)[153], and Bozeman (n = 893).[223]

On average, the use of the CEW reduces subject injuries by about 2/3. To put it another way, the use of alternative control techniques triples (3x) the risk of injury to subjects. Fatal suspect shootings are also reduced by 2/3 when electronic control is used without excessive restriction. [3]

a. The deployment and use of TASER CEWs has been shown to reduce injuries to officers and subjects over other force options, including physical force.[1]
b. The deployment and use of TASER CEWs has been shown to reduce use-of-force civilian complaints and law enforcement internal affairs complaints against law enforcement officers.[224]
c. The deployment and use of TASER CEWs has resulted in the reduced need to use deadly force.[3,12]
d. Rates of injury from TASER CEWs is less than several other common law enforcement force options, including, but not limited to: physical force, chemical aerosols, batons, impact tools, canines, rubber bullets, and bean bags.
e. TASER CEWs are a safer alternative than other comparable law enforcement force options tools or techniques.
f. TASER CEWs are shown to reduce subject injuries when compared to physical force options.
g. TASER CEWs have greater accountability features than any other force option.
h. TASER CEWs are the most studied force option available to law enforcement.
i. TASER CEWs are the most effective force option in gaining compliance without need for deployment or application (up to 81%).[225]

The TASER CEW reduces subject injuries and fatalities.

General Comments

Previous Testimony

I have testified as an expert at trial or by deposition within the preceding 4 years in:

1. Criminal case of Texas v Murray, Brazoria County State Court, TX. (Apr 2017) D
2. Excessive force case of Khottavongsa v Brooklyn Center, MN . US District Court, St Paul, MN. (June 2017) D
3. Electrical injury case of Rowan v Sunflower. US District Court, Kansas City, KS. (Sept 2017) D
4. Electrical injury case of Garcia v Natchitoches, 10th Judicial District Court. Natchitoches City LA. (Sept 2017) D
5. Patent Inter-Party Review of Nevro v Boston Scientific re US #6895280, Wash. DC. US Patent Appeals Board. (Apr 2018) P
6. Patent Inter-Party Review of Nevro v Boston Scientific re US #7587241, Wash. DC. US Patent Appeals Board. (Apr 2018) P
7. Wrongful death case of Aguilar v Los Angeles PD. US District Court, Los Angeles, CA. (May 2018 and May 2019) D
8. Wrongful death case of Ramos v East Hartford, CT. US District Court, Hartford, CT. (June 2018) D
9. Wrongful death case of Todero v Greenwood, IN. US District Court, Indianapolis, IN (Sept 2018) D
10. Wrongful death case of Silva (Haleck) v Honolulu, HI. US District Court, Honolulu. (May 2019) D
11. Wrongful death case of Wood v Entergy. Arkansas District Court, AR. (May 2019) P
12. Patent case of Cardionet v Infobionics. US District Court, Boston, Massachusetts. (Sept 2019) D
13. Labor arbitration of Payne v Omaha, NE. US Dept of Labor (Oct 2019) P
14. Wrongful death case of Timpa v Dallas, TX. US District Court, Dallas, TX (Dec 2019) D
15. Criminal case of USA vs. Burton Ritchie. US District Court, Las Vegas, NV (Jan 2020) P
16. Starke v Astar et al. Florida District Court, St. John's County, FL (Apr 2020) D
17. Patent Inter-Party Review of Nevro v Boston Scientific re US #9162071, Wash. DC. US Patent Appeals Board. (Apr 2020) P
18. Patent Inter-Party Review of Nevro v Boston Scientific re US #8682447, Wash. DC. US Patent Appeals Board. (Apr 2020) P
19. Patent Inter-Party Review of Nevro v Boston Scientific re US #6381496, Wash. DC. US Patent Appeals Board. (Apr 2020) P
20. Loftis v American Electric Power. US District Court, Charleston, WV (Oct 2020) D

Fees:

My fees for this expert consultant report are $480 per hour for the research and preparation, plus expense reimbursement. My fees for testimony (at trial or deposition) are $480 per hour plus anticipated expense reimbursement and are due prior to the commencement of a deposition. Fees for travel are portal-to-portal and are $240 per hour when not performing work billable at $480 per hour.

Right To Amend:

The opinions in this report are living opinions. Should additional discovery material be received, or additional research be completed, and then reviewed, these opinions may be altered or reinforced depending upon what information is obtained, reviewed, or studied. If new issues are opined, identified, or developed subsequent to submission of this report, I reserve the right to supplement, or further supplement, this report. *I especially reserve the right to amend my report after receiving new forensic evidence.*

Further Development:

Further, the opinions, which are expressed in this report, are listed to comply with current report requests. Each opinion may be further developed through research, investigation, during deposition or trial testimony.

Specific References:

Some of the opinions in this report may list specific references to some of the case specific documents reviewed or considered. These listings are not intended to be all-inclusive. I specifically reserve the right to supplement the support for each of the opinions in this report.

Opinion Methodology:

The enclosed opinions were developed using the disciplines of bioelectricity, electrophysiology, biomedical science, cardiovascular physiology, scientific methods, mathematics, and physics and are to a reasonable degree of professional and scientific certainty.

Additionally, the opinions provided in this case were developed using one or more qualitative and quantitative research methodologies, in addition to my education, training, experience, and literature review.

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